The Changing Structure of Agricultural Trade in North America

Pre- and Post-CUSTA/NAFTA: What Does It Mean?

Thomas L. Vollrath and Paul V. Johnston, Economic Research Service, USDA

Introduction

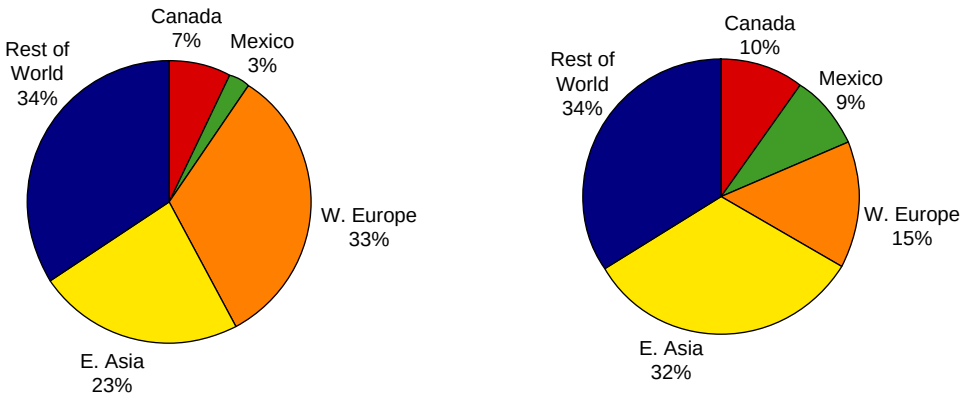
Major changes have recently occurred in the structure of U.S. and world agricultural trade. The composition of such trade has shifted away from bulk commodities towards high-value products. Moreover, U.S. agricultural trade with both Canada and Mexico has grown faster than U.S. exports to and imports from other partners.

What do these structural changes tell us about the success of the Canada-U.S. Free Trade Agreement and the North American Free Trade Agreement (CUSTA/NAFTA)? Here, some likely implications are deduced, using objective intelligence derived from agricultural trade statistics. These statistics, grounded in theory, are calculated from source-destination trade flow data. Of particular interest are indexes measuring bilateral trade intensity, commodity complementarity, and trade bias. These indexes can be used in summarizing and diagnosing structural change.

Adapted from a poster presentation at the annual meetings of the American Agricultural Economics Association and the Canadian Agricultural Economics Association, Chicago, August 5-8, 2001.

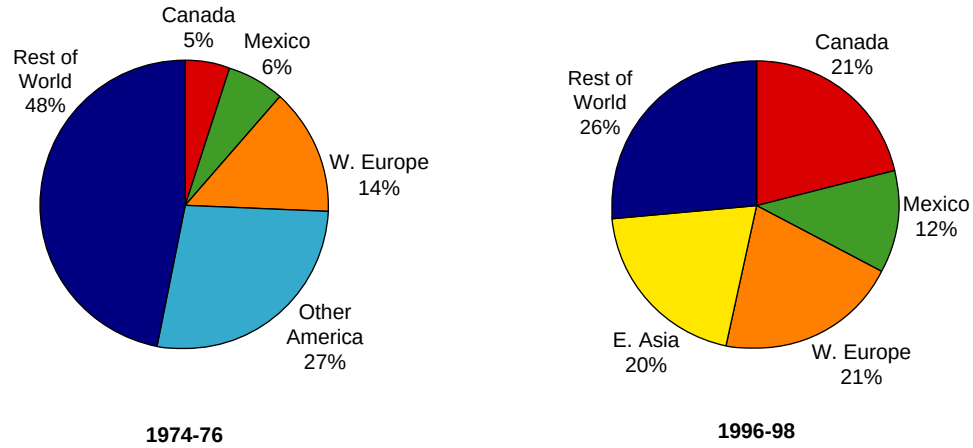
Changes in the distributional structure of U.S. agricultural exports show greatest expansion in the NAFTA market

Destination of U.S. agricultural exports



NAFTA suppliers show the greatest success in capturing additional share of the U.S. market

Origin of U.S. agricultural exports



How can structural change in trade be quantified?

What does "bilateral trade intensity" measure?

The bilateral trade intensity statistic (IT) gauges an exporter's penetration of an importer market within the context of overall world trade. A *simplified* formula of this indicator is: [2]

$$IT_{ij} \equiv \frac{X_{ij}/X_{iw}}{M_{jw}/M_{ww}} \equiv \frac{\text{share of i's exports sent to j}}{\text{j's share of global imports}}$$

Abstracting from transportation margins, this index can be reconfigured to focus on the exporting country and its competing suppliers in market j. [3] The IT index becomes simply a ratio of destination shares (ds):

$$IT_{ij} \equiv \frac{ds_{ij}}{ds_{wj}} \equiv \frac{X_{ij}/X_{iw}}{X_{wj}/X_{ww}} \equiv \frac{\text{share of i's exports going to j}}{\text{share of world's exports going to j}}$$

Similarly, the bilateral trade intensity index can be rearranged as a ratio of market shares (ms). This configuration focuses attention on the importing country and alternative import suppliers:

$$IT_{ij} \equiv \frac{ms_{ji}}{ms_{wi}} \equiv \frac{M_{ji}/M_{jw}}{M_{wi}/M_{ww}} \equiv \frac{\text{share of j's imports from i}}{\text{share of world's imports from i}}$$

Keys to algebraic notation

i = exporter
j = importer
us = United States
w = world
k = commodity
s = sector
ag = agriculture
ds = destination share
ms = market share
X_{ij} = exports from i to j = M_{ji} = imports by j from i.
1989 = beginning of CUSTA
1994 = beginning of NAFTA

[2] See box entitled "Eliminating own-country bias" at the end of this document.

[3] If there are no transaction costs, exports from i to j (X_{ij}) is equivalent to imports by j from i (M_{ji}).

Bilateral trade intensity index: keys to interpretation

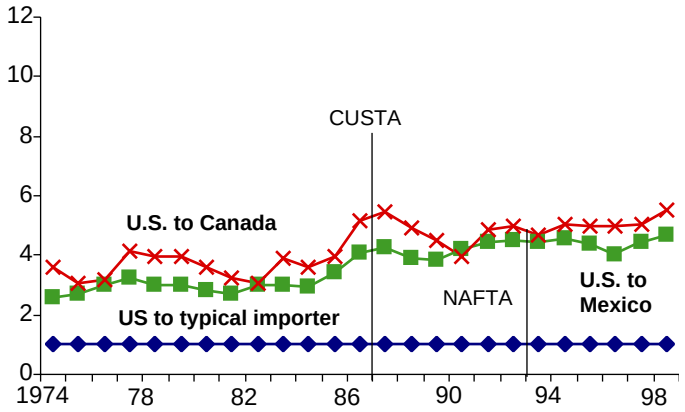
* A unitary IT_{ij} shows that there is no difference in the importance to nation i of supplying imports to j than in supplying imports elsewhere in i's foreign market.
* Viewed from the perspective of the exporter (using relative destination shares), an $IT_{ij} > 1$ shows that nation j is a more important market for exporter i than for the typical country exporting to j. Similarly, if $0 < IT_{ij} < 1$, then nation j is a less important market for exporter i than for the typical country exporting to j.
* Viewed from the perspective of the importer (using relative market shares), an $IT_{ij} > 1$ demonstrates that nation i is more important supplying nation j with needed imports than in supplying "other" importing countries. Similarly, if $0 < IT_{ij} < 1$, then nation i is less important supplying nation j with imports than in suppling "other" importing countries.

IT_{ij}'s can be calculated for any individual commodity k as well as for any sector aggregate s. They permit comparisons to be drawn across destination and/or origin markets by controlling for market size.

Historically, U.S. agricultural exports to Canada (Mexico) are 3.6 (4.3) times greater than would be expected after controlling for market size. These findings underscore the importance of NAFTA markets to U.S. agricultural exporters. Similarly, Canada and Mexico are heavily reliant upon the United States to absorb their agricultural exports. On average, the U.S. agricultural imports from Canada (Mexico) are 3.5 (8.3) times greater than imports from the typical supplier importing to the United States.

"Neighborliness" is an important factor explaining the geographical distribution of U.S. agricultural exports

U.S. export intensifies with its trading partners, $IT^{ag}_{us\ j}$



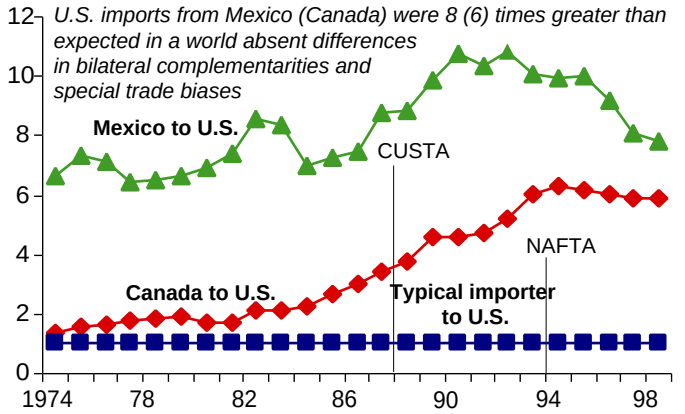
U.S. export penetration shows that Canada and Mexico imports from the U.S. are 4 to 5 times greater than expected post-CUSTA/NAFTA

At the sector level of analysis, IT^{s}_{ij} can be decomposed into two components—a complementarity index (CC^{s}_{ij}) and a trade bias index (TB^{s}_{ij}) in the following way:

$$IT^{s}_{ij} \equiv CC^{s}_{ij} * TB^{s}_{ij} \equiv$$ commodity complementarity times trade bias within the s-sector

U.S. imports more intensively from Mexico than from Canada, but U.S. import reliance upon Canada increased post CUSTA/NAFTA

U.S. import intensifies with its trading partners, $IT^{ag}_{i\ us}$



U.S. imports from Mexico and Canada were 9 to 5 times greater than expected post-CUSTA/NAFTA

What is the significance of "commodity complementarity"?

The commodity complementarity (CC^{s}_{ij}) index correlates nation i's export specialization pattern with nation j's import specialization pattern across the spectrum of all traded products. CC^{s}_{ij} is a trade-weighted measure for sector s of the degree to which the relative-export-share structure of nation i's exports (RXS_i) corresponds with the relative-import-

share structure of nation j's imports (RMS_j) across all k comodities within the s sector:

$$CC_{ij}^{s} \equiv \sum_{k \in s} \left[\theta^{k} * RXS_{i}^{k} * RMS_{j}^{k} \right], \text{ where}$$

$$RXS_{i}^{k} \equiv \frac{X_{iw}^{k} / X_{iw}^{s}}{X_{ww}^{k} / X_{ww}^{s}} \equiv \frac{\text{share of k in i's exports of s goods}}{\text{share of k in the world's exports of s goods}} \; ;$$

$$RMS_{j}^{k} \equiv \frac{M_{jw}^{k} / M_{jw}^{s}}{M_{ww}^{k} / M_{ww}^{s}} \equiv \frac{\text{share of k in j's imports of s goods}}{\text{share of k in the world's exports of s goods}} \; ;$$

$$\theta^{k} \equiv \frac{X_{ww}^{k}}{X_{ww}^{s}} \equiv \text{share of k in global exports of s goods.}$$

RXS_{i}^{k} is Balassa's *revealed comparative advantage.* RMS_{j}^{k} has the same structure, except that import rather than export data are used. In other words, the CC_{ij}^{s} index can be interpreted as being a trade-weighted measure for sector s of the degree to which exporter i's profile of "comparative advantages" corresponds with the profile of "comparative disadvantages" for importer j. Put another way, this index depicts how specialization in the commodity composition of nation i's exports to the global market meshes with the specialization in the commodity composition of nation j's imports from the international market.

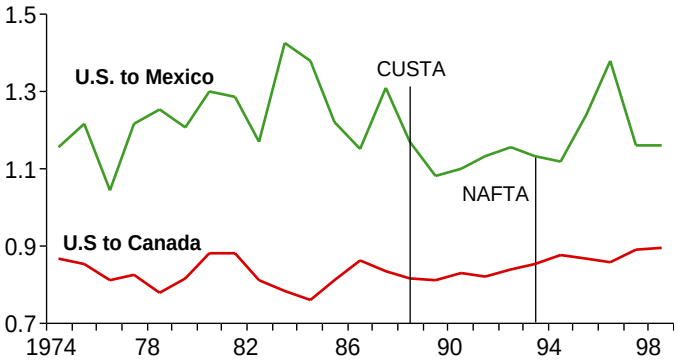
Commodity complementarity index: keys to interpretation

* There is always some degree of complementarity in bilateral specialization patterns, provided i exports some goods that j imports within the sector s.
* CC_{ij}^{s} equal to one represents a threshold, with a value greater (less) than one showing a greater (lesser) level of complementarity in the composition of what exporter i exports and what importer j imports than occurs between the average pair of countries.
* Upward sloping CC_{ij}^{s}'s provide evidence that the structural change taking place is consistent with more efficient use of both partner and global resources. Such change is very likely to be welfare enhancing.

Through time, complementarities of U.S. and Mexican trade in agricultural products are greater than complementarities depicting corresponding U.S. and Canadian trade. This is largely attributable to the fact that the United States and Canada specialize in the production of grain and oilseeds while Mexico specializes in the production of tropical fruits and vegetables. The good news is that the empirical record reveals deeper bilateral complementarities between Canada and Mexico after the CUSTA and NAFTA agreements. By 1998, the United States, Canada, and Mexico were more effectively exploiting national comparative advantages than when the free trade agreements were first ratified.

Complementarity in the composition of U.S. exports and NAFTA-member imports show improvement from the beginning to the end of the post-free trade agreement periods

Correlation of U.S. export specialization and NAFTA-member import specializations across the spectrum of agricultural products, $CC^{ag}_{us\ j}$



The commodity/product make-up of agricultural trade used to calculate CC:

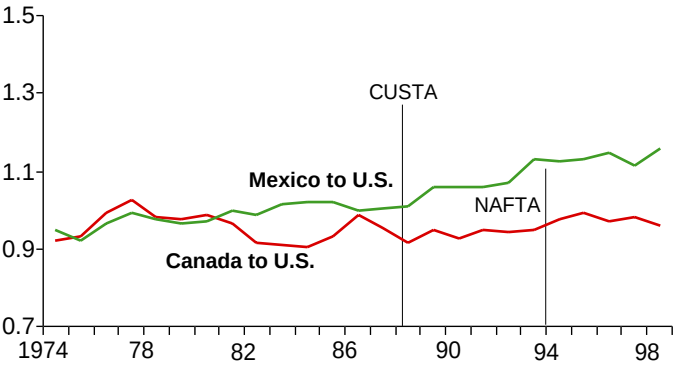
- Bulk commodities
- Processed intermediates
- Produce and horticultural products
- Processed high-value products

What does "trade bias" mean?

The trade bias (TB^{s}_{ij}) index measures the deviation of actual from expected bilateral trade. Exporter i's expected (or hypothetical) trade with partner j, $\overline{X}^{s}_{ij}$, is the sum of the product of importer j's total imports for each commodity multiplied by the share of exporter i in supplying the rest of the world each commodity.

Complementarity in the composition of U.S. imports and NAFTA-member exports show improvement from the beginning to the end of the post-free trade agreement periods

Correlation of U.S. import specializations and NAFTA-member export specializations across the spectrum of agricultural products, $CC^{ag}_{i\ us}$



The commodity/product make-up of agricultural trade used to calculate CC:

- Bulk commodities
- Processed intermediates
- Produce and horticultural products
- Processed high-value products

$$TB^{s}_{ij} \equiv \frac{X^{s}_{ij}}{\overline{X}^{s}_{ij}} \equiv \frac{\text{i's actual exports to j of s-sector goods}}{\text{i's expected exports to j of s-sector goods}}, \quad \text{where}$$

$$\overline{X}^{s}_{ij} \equiv \sum_{k \in s} \left[M^{k}_{jw} * \left(\frac{X^{k}_{iw}}{X^{k}_{ww}} \right) \right] \equiv \text{j's imports of good k times i's share of world exports of k summed over all goods in the s-sector}$$

TB_{ij}^{s} captures how such special country effects as distance, transportation costs, tariffs, quotas, and discriminatory policies affect the geographical pattern of trade.

Trade bias index: keys to interpretation

* The greater the value of TB_{ij}^{s}, the more differential transaction costs, due to special country effects, contribute to the intensity of trade between a particular buyer and seller.
* Many factors affecting partner bias—such as differences in language, tastes and preferences, and political systems—inhibit trade but change slowly, if at all.
* Other sources of bias, most notably shifts in partner policies, can arise suddenly with varying impacts on bilateral trade frictions.

Use of the IBAT analytical database

Critical to this research is the *International Bilateral Agricultural Trade* (IBAT) analytical database, developed at the Economic Research Service (ERS) and derived from the United Nations *Comtrade* data. IBAT data are both consistent and reconciled, unlike that found elsewhere. Consistency means that there are no discrepancies between country and commodity totals. Reconciliation relates to the resolution of problems associated with misclassification of reported trade, the use of different UN (United Nations) coding systems (i.e., Rev1, Rev2, Rev3, HS), and discrepancies in exporter and importer reports for any given commodity flow. Here, we calculate all three analytical indexes using free-on-board (fob) export data.

Policy impacts

In most cases, the intensity of bilateral trade among North American countries increased for total agriculture after CUSTA/NAFTA. The notable exception was Mexican exports to the United States. This exception does not reflect a failure of NAFTA, but rather the success of a policy re-orientation in Mexico focused on establishing outlets other than the United States for its products. In recent years, Mexico has pursued bilateral agreements with the European Union, Chile, Costa Rica, Mercosur, and other trading partners with the aim of widening the market for its exports.

Classical trade theory clearly establishes the fact that societies gain from increased specialization and trade. Commodity-complementarity indexes, unlike the other statistical measures presented herein, provide a basis for drawing welfare implications from structural changes taking place within the world economy. These indexes embody

important dimensions of comparative advantage, see algebraic formulations. Our empirical findings show intensification of U.S./Canadian (U.S./Mexican) complementarities from 1989 to 1998 (1994 to 1998). They also show that the downward trends depicting U.S./Canada complementarities prior to 1989 reversed direction thereafter. These results suggest that shifting trade patterns post-CUSTA/NAFTA benefit the United States, its two neighboring partners, and global agriculture.

Eliminating own-country bias

The algebraic formulations presented in this document highlight important economic relationships and draw attention to linkages among the various indexes. Adjustments can be made to eliminate bias in the three indexes arising from the fact that an exporter does not export to itself. To circumvent this bias, the charts shown here are based upon Brown's modified measure of bilateral trade intensity as well as Drysdale's modified measures of complementarity and aggregate trade bias. The adjusted indexes normalize the importance of j as a market for i's exports, not by the importance of j in the world market, but rather by the importance of j as a market in i's foreign market. The difference between i's foreign export market and the world market can be substantial, especially whenever the focus is on a large country, such as the United States, which is a sizeable importer.

Bibliography

Anderson, Kym. "Intensity of Trade Between Pacific Basin Countries," *Pacific Economic Papers*, No. 102. Australia-Japan Research Centre, July 1983.

Anderson, Kym and Hege Norheim. "Is World Trade Becoming More Regionalized?" *Review of International Economics*, Vol. 1, pp. 91-109, 1993.

Balassa, Bela. "Trade Liberalization and `Revealed' Comparative Advantage." *The Manchester School of Economic and Societal Studies*, Vol. 33, pp. 99-123, 1965.

Brown A. J. *Applied Economics: Aspects of the World Economy in War and Peace*. Edinburgh: Hugh Paton and Sons Ltd., 1947.

Drysdale, Peter. "Japanese-Australian Trade." Ph.D. Dissertation. Australian National University, Canberra, 1967.

Drysdale, Peter and Ross Garnaut. "Trade Intensities and the Analysis of Bilateral Trade Flows in a Many-Country World: A Survey," *Hitotsubashi Journal of Economics*, Vol. 22, No. 2, pp. 62-84, Feb. 1982.

Drysdale, Peter. *International Economic Pluralism: Economic Policy in East Asia and the Pacific*. Sydney: Allen & Unwin. 1988.

Frankel, Jeffrey A. *Regional Trading Blocs In the World Economic System*. Institute for International Economics, Washington, D.C., Oct. 1997.

Hertel, Thomas W. "Evolving Patterns of Integration in the North American Market and the Impact of NAFTA." North American Integration and Its Impact on the Food and Fiber System: A Symposium, Washington, D.C., November 6-7, 2000.

Hufbauer, Gary Clyde and Jeffrey J. Schott. *NAFTA: An Assessment*. Institute for International Economics. Washington D.C., 1993.

Kojima, Kiyoshi. "The Pattern of International Trade Among Advanced Countries." *Hitotsubashi Journal of Economics*, Vol. 5, pp. 16-36, June 1964.

Kunimoto, Kazutaka. "Typology of Trade Intensity Indicies." *Hitotsubashi Joural of Economics*, Vol. 17, pp. 15-32, Feb. 1977.

Roemer, John E. "The Effect of Sphere of Influence and Economic Distance on the Commodity Composition of Trade in Manufactures." *The Review of Economics and Statistics*, Vol. 59, pp. 318-27, 1977.

Vollrath, Thomas L. "The Impacts of NAFTA and CUSTA on Agricultural Trade Flows: Changing Agricultural Trade Patterns in North America." Presented at workshop on North American Trade Relationships: Policy Challenges for 2002 and Beyond, at annual meetings of the American Agricultural Economics Association and Canadian Agricultural Economics Association, Chicago, August 8, 2001.
http://www.farmfoundation.org/north_american_trade_relationships.htm

Vollrath, Thomas. "Diagnostic Indexes of U.S. Bilateral Trade" *Technical Bulletin*, No. 1812, ERS, USDA, Dec. 1992.

Yamazawa, Ippei. "Structural Changes in World Trade Flows," *Hitotsubashi Journal of Economics*, Vol. 11, pp. 11-21, Feb. 1971.